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AUTHOR Kutina, Kenneth L.; And Others
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ABSTRACT

A simulation model of an academic medical center that was developed to aid in strategic planning and policy analysis is described. The model, designated MCM for Medical Center Model, was implemented at the School of Medicine, University Hospitals of Cleveland, and the private practices of the faculty in the clinical departments at University Hospitals. The model uses an approach known as system dynamics, which evolved from the application of feedback control theory to dynamic socioeconomic systems. The model is particularly well suited to incorporation of factors normally considered to be qualitative, and to assessing impacts of exogenous constraints and influences. In addition to using the system dynamics approach and the Dynamo language, MCM takes into account such factors as the effect of quality of plant and equipment on the ability to recruit faculty, the impact of level of student aid on the ability to recruit students, and the synergistic effects that appear in research productivity once an institution's programs exceed a certain minimum. The form and magnitude of the relationships involving such effects were generally estimated based on discussion with key people who have relevant experience in the institutions. The validity of such estimates is being assessed by setting parameters in the model so that it will react to a specific effect, and then reviewing model outputs with knowledgeable people. For illustration, the following three analyses are briefly examined: reduction of the Guaranteed Student Loan Program, hospital marketing, and reduction of indirect expense recovery by the National Institutes of Health. Diagrams of the model are appended. (SW)

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# QUALITATIVE AND POLITICAL ISSUES IMPACTING ACADEMIC MEDICAL CENTER STRATEGIC PLANNING - A METHODOLOGICAL APPROACH

Kenneth L. Kutina, Ph.D.

Senior Associate Dean

and

Edward A. Bruss, M.S.

Director of Institutional Studies

School of Medicine

Case Western Reserve University

Cleveland, Ohio 44106

(216) 368-2796

and

Mark Paich, M.A., Graduate Student

Sloan School of Management

Massachusetts Institute of Technology

Boston, Massachusetts 02139

(617) 253-1588

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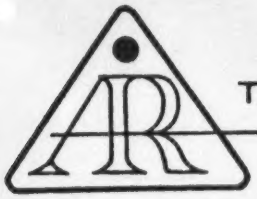

THE ASSOCIATION FOR INSTITUTIONAL RESEARCH

This paper was presented at the Twenty-Second Annual Forum of the Association for Institutional Research held at the Denver Hilton Hotel in Denver, Colorado, May 16-19, 1982. This paper was reviewed by the AIR Forum Publications Committee and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC Collection of Forum papers.

D. R. Coleman, Chairman
Forum Publication
Advisory Committee

Abstract

Using an approach known as system dynamics, which evolved from the application of feedback control theory to dynamic socio-economic systems, a simulation model of an academic medical center was developed to aid in strategic planning and policy analysis. This paper describes the structure and application of the model, which is particularly well suited to incorporation of factors normally considered of a qualitative nature, and to assessing impacts of exogenous constraints and influences.

PERSPECTIVE

Among institutions of higher education, the academic medical center is, by its very nature, not only subject to most of the same external demands, competitive pressures, and constraints as its collegial institutions of higher education in other fields, but because it encompasses entities whose primary mission is the delivery of health care, it is also impacted by a host of other political, financial, demand, and competitive pressures characteristic of that industry.

In developing long-range strategic plans and carrying out policy analyses, it is imperative that the planners and chief executive officers of such institutions have a capability of assessing the programmatic, operational, and financial impact on the system which various educational, research, and health services-related internal and external forces can incur. Simulation modeling is a valuable, proven tool to assist in such analyses, and a few simulation models have been developed and reported in the literature which are specifically oriented to medical school or academic medical center corporate strategic planning.

The earliest application known to the authors was the landmark work done by the Health Sciences Functional Planning Unit at the University of Toronto in the late sixties (Judy, 1969). Although this model had financial and staffing sectors, its core was a highly detailed, activity-based simulation of the undergraduate medical education curriculum (leading to the M.D. degree) which was aimed primarily at determining the fluctuations in instructional work load per week on the various medical school departments over the course of a year as a result of curricular changes. Kutina and Lee (1974) reported on a more comprehensive model developed at Case Western Reserve University (CWRU), which encompassed educational, research, and

patient service programmatic demands on the faculty, calculated staffing requirements, and generated cost and income analyses by program. Like the Toronto model, it also concentrated on the school component of the academic medical center and treated the demands and resources generated by hospital programs as exogenous inputs. A similar model set was developed at about the same time at the University of Vermont (Forsyth, Laverty, and Hebert, 1975). It focused on assessing the impact of curricular and enrollment changes in the undergraduate medical education and residency programs, and on producing estimates of academic program costs.

The models described above all concentrate primarily on the educational sector of the academic health center, and use a deterministic, non-dynamic approach to simulation modeling. It is characteristic of such models that they use exact algebraic relationships that do not vary over time. The model described in this paper was formulated to more rigorously encompass the programs of the primary teaching hospital along with those of the medical school, and to clearly capture the dynamic programmatic and financial interconnections between the institutional entities. It includes feedback loops which can alter cause-effect relationships over time, and uses a simulation modeling approach known as "system dynamics" (Richardson and Pugh, 1981).

System dynamics methodology grew out of the application of feedback control systems theory to dynamic socio-economic systems (Forrester, 1968). It has been applied over the past two decades to a wide variety of industrial, economic, urban development, and health and human services delivery problems (Roberts, 1978). However, there appear to be few applications which are oriented to higher education institutional planning. Probably the earliest application was a thesis project at the University of

Washington which links student flows, faculty flows, educational space requirements, and budgetary impact (Thompson, 1970). This model does not appear to incorporate research as a major activity, nor does it include the patient service sector inherent in an academic medical center.

A system dynamics model developed for long-range planning at the University of Vermont's Division of Health Sciences and its affiliated hospital, the Medical Center of Vermont, focuses on the problem of utilization of the hospital by patients. This interesting model "captures the circular relationships among utilization (census), revenues, investments, and factors that directly affect admissions such as the availability of specialized equipment and the modernness of all equipment and facilities". (Hirsch, Forsyth, Bergan, and Goodman, 1976, p. 938). The authors report that this model has been employed in the institutions' long-range planning processes.

Still more recently, the system dynamics approach was employed in a project at the Tufts University School of Medicine to aid in developing an intervention strategy to bring about organizational and behavioral changes influencing interpersonal functioning between the school and its affiliated hospitals. In this application, the structuring of system dynamics models was used primarily as an educational and documentation aid to "promote openness and a new sense of mutual trust by focusing attention on organizational rather than individual goals and relating discussions to models rather than personalities" (Stearns, Bergan, Roberts, and Cavazos, 1978, p. 465).

The work reported in this paper is an expansion of the previous efforts described above and was aimed at yielding an academic medical center comprehensive strategic planning model utilizing the system dynamics

approach and principles. It was felt that such a model would be a valuable aid in assessing the impact of political and other external forces affecting the institutions, as well as for analyzing internally generated strategic planning issues.

## THE ACADEMIC MEDICAL CENTER

This model (designated "MCM" for "Medical Center Model") was implemented for the academic medical center at CWRU comprised of the School of Medicine, University Hospitals of Cleveland (UH), and the private practices of the faculty in the clinical departments at UH. It also incorporates the Medical School's interaction with its faculty located at four other affiliated major teaching hospitals. Figure 1 displays the primary organizational units, variables, and elements of the Academic Medical Center which are included.

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INSERT FIGURE 1 ABOUT HERE

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Quantitative data for implementation and validity testing of the model came, for the most part, from standard accounting and operating reports of the involved institutions. Further information concerning programmatic, operational, and financial relationships was gathered via in-depth discussions with the chief executive officers and planning professionals of both the School and the Hospital.

## METHOD

Consisting of approximately 600 variables (many of which are vectors consisting of up to 12 elements), operating in a like number of equations, MCM is programmed in a special purpose system dynamics language known as "Dynamo" (Pugh, 1976), and is running on CWRU's DEC 2060 computer.

Figure 2 is a very simplified overview of the model logic designed to illustrate the way MCM handles some of its major variables and linkages.

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INSERT FIGURE 2 ABOUT HERE

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The diagram uses standard system dynamics symbols in which rectangles represent "level" variables. Thus, the number of faculty, for example, is handled computationally like a liquid level in a tank. Faculty leaving the institution because of retirement, resignation, termination, etc. tend to reduce or lower the level, while new hires raise the level. Obviously, if the same number of faculty are hired as leave in a given year, the number of faculty "on board" (the liquid level in the tank) remains stationary. The value of plant and equipment is also a level variable, being reduced by depreciation (the user can also take facilities out of service if desired, thereby simulating demolition, sale, or "mothballing"), and increased by fresh investment. There are many other level variables used in the model (such as for student enrollments, the value of equipment, the levels of funds balances, etc.) which are not shown in this particular diagram for the sake of clarity. The closed "x's" on the inflows and outflows from levels represent valve-like functions controlling flow rates, which are often varied by other factors in the model. The cloud-like images at the ends of the inflow and outflow arrows indicate either that the flow connects with some other part of the model not shown in the diagram, or simply represents a flow in or out of the total system being modeled. In general, solid arrows in these diagrams represent actual flows of something - people, money, materials, etc. Dotted arrows indicate a cause-effect relationship.

Some of the relationships between variables, required in structuring a system dynamics model such as MCM, are not known with quantitative

precision. However, this does not prevent implementation of a model, or deter from its usefulness in understanding the dynamic behavior of a system for planning purposes, if people knowledgeable about the system have a general understanding of the nature of the response mechanisms between the variables and can describe them in graphical terms. Such relationships, which are normally thought of as "qualitative", can readily be incorporated in system dynamics models. As stressed in the text by Richardson and Pugh (1981), "The premise is that dynamic behavior is a consequence of system structure" (p. 15), and realistically capturing system structure in the model does not necessarily require precise numerical data to estimate equation parameters or coefficients.

The relationship, shown in Figure 2, between the level of the dollar value of plant and equipment (a surrogate for quality of the facilities) and the ability to hire faculty, is an example of the above. An equation representing this relationship is not known with precision. However, academic leadership at the institutions, experienced in recruiting faculty, feel that the variables are related approximately as shown in Figure 3.

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INSERT FIGURE 3 ABOUT HERE

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This graph was created by arbitrarily setting the effect on hiring at one when all facilities are in fully up-to-date condition. The judgement of experienced people was that the impact of this variable on their ability to recruit faculty would be small until a significant proportion (perhaps 25 percent) of the facilities was in need of upgrading. If a greater proportion of space became marginal, it was felt the ability to recruit faculty would suffer sharply. Finally, it was felt, when most of the facilities were in poor condition, the effect would level out on the grounds

that one would probably find some minimal number of faculty who would still join the institutions in spite of the condition of the physical plant.

Figure 4 illustrates another section of the model, relating to the graduate (Ph.D. and M.S.) programs, in which most of the relationships can be established with some degree of algebraic and numeric precision, but a few require the application of the technique described above.

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INSERT FIGURE 4 ABOUT HERE

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The diagram shows that the number (level) of graduate students is determined by the admission rate and the graduation rate. The number graduating is, of course, a function of the numbers enrolled as shown, and the average length of time in residence (not shown in the diagram). Since there is intense competition for good graduate students, the number that can be recruited is a function of the difference between average available support per student and the tuition rate, or "net student aid."

Figure 5 shows the relationship that is used to indicate the effect that the level of net student aid has on the institution's ability to recruit graduate students.

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INSERT FIGURE 5 ABOUT HERE

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In this case the variable, net student aid, was "normalized" by dividing each future simulated level by its value for the base year (1980/81). The graph indicates that when the net student aid is at the same level as it was in 1980/81, the "net student aid ratio" is one and the effect is one. In this situation there is no positive or negative influence exerted by this variable in the model. This graph again displays the S-shaped relationship, indicating a large impact of changes in student aid up or down from the

current level, but leveling at the extremes. The thinking relevant to the leveling at the lower end of the curve is that a few students will still come, even with no financial aid. At the upper extreme, even with substantial student aid offered, there is only a finite number of applicants available in the pool which limits the maximum number that can be recruited.

It is interesting to contrast the curve used in MCM for relating the net student aid ratio for medical students to the effect on their recruitment to that just illustrated in Figure 5 for graduate students. Figure 6 depicts this relation, and indicates a much less "price elastic" market. There is much more competition among applicants to get into medical school and varying the net cost to students has much less impact on the ability of a school to fill its classes (Ayers, Stangert, Dennis, & Henry, 1981).

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INSERT FIGURE 6 ABOUT HERE

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The main programmatic outputs from the academic medical center - education, research, and patient service - in a sense "compete" with each other for faculty time. As shown in Figure 7, the model portrays this allocation by assuming that faculty time required for teaching is a function of the number of students, and that this demand receives first priority. Remaining faculty time is allocated by the model between patient service and research in accordance within user-adjustable limits.

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INSERT FIGURE 7 ABOUT HERE

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As also shown in Figure 7, the amount of revenue generated by patient service and research activities is affected by the faculty time devoted to each.

Figure 8 indicates some of the important aspects of the patient care sector of the model including the four primary sources of income for these activities. It shows that the number of admissions to the Hospital inpatient service is a function of the number of ambulatory visits to the emergency room, to the Hospital outpatient clinics, and by private patients to individual full-time faculty. In addition, part-time faculty admit patients directly to the hospital inpatient service even though the patients have not been seen on an outpatient basis at the Hospital.

In MCM, the number of "inpatient days of care" is generated as a function of the number of admissions by medical service. The number of surgical procedures performed is computed based on the number of admissions to the various surgical services. The number of units of ancillary services (laboratory tests, radiologic exams, etc.) required is a function of both the number of outpatient visits and inpatient admissions. The charges for care are calculated as a function of the units of various services delivered. To determine source of payment, the model uses a typical coverage profile representative of each catagory of patient. In MCM, the number of emergency room visits and visits to the Hospital's outpatient clinics are treated as exogenous inputs controllable by the user. Since ambulatory visits by private patients are to a specific individual physician, the number of such visits is calculated in the model as a function of the number of full-time faculty.

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INSERT FIGURE 8 ABOUT HERE

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It should be stressed that the various diagrams and graphically portrayed relationships discussed in the preceding paragraphs are not meant to be an exhaustive description of MCM. Rather, the authors have attempted

to include an adequately representative sampling to meaningfully illustrate the nature and breadth of the model.

## USING THE MODEL

As mentioned earlier, 1980/81 was used as the base year for the implementation of the MCM. Estimates of parameters and coefficients were based on institutional data from that year and the integrity of the model structure was tested by comparing its outputs to actual data from the base year. The model also underwent extensive additional testing by carefully varying single factors over long simulated time periods. Results of such runs were then assessed by the authors and other key School and Hospital personnel for reasonableness.

MCM is being used to analyze the possible impact of a variety of external political and environmental forces, as well as to assess the potential results of internally generated planning and policy initiatives. For illustrative purposes, three such analyses are briefly examined in the following sections.

### Reduction of the Guaranteed Student Loan Program

There has been much discussion at the national level concerning proposals to sharply curtail the Guaranteed Student Loan Program. Reduction of such relatively low interest rate sources of funds for students would dramatically alter downward the curves shown in Figures 5 and 6. For illustrative purposes, the authors hypothesized that the effect on graduate student recruitment might be reflected by the dotted curve in Figure 9.

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INSERT FIGURE 9 ABOUT HERE

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When data from the dotted curve in Figure 9 were utilized in an MCM simulation spanning a twenty-year period and compared with a base run which left the solid curve in place, the authors observed a dramatic retrenchment occuring especially in the basic science departments of the School. Although the School was able to maintain a balanced budget, the enrollment in the graduate program, the number of faculty in the basic sciences, and research grant revenue all fell to new steady state levels significantly below current conditions. After fifteen simulated years, the enrollment in the graduate programs stabilized at about 66 percent of its original level, the number of faculty at about 82 percent, and research revenue at about 87 percent. These variables do not bear simple direct relationships to one another, and the net or compound impact on a given variable is not always immediately obvious. Research revenue, for example, is linked positively with the number of faculty, the number of graduate students, and the amount of time faculty have for research. As the number of faculty and graduate students declines, one would expect a negative impact on research revenue; however, with declining enrollment, faculty time to teaching falls, thereby allowing more time for research and a resultant positive impact on research revenue. The net result of these multiple factors and feedback effects is that research revenue declines less than one might expect, given the catastrophic shock to the graduate program.

## Hospital Marketing

One strategy that can be considered for improving the Hospital's fiscal position is to, via a deliberate recruitment policy, shift the complement of part-time faculty toward one with a profile of patients more financially attractive to the Hospital. This would mean recruiting community physicians

to join the part-time staff of admitting physicians most of whose patients are covered by private carriers such as Blue Cross or commercial insurers. These "third-party payers" traditionally cover a much higher proportion of hospital costs than most government programs such as Medicaid, Medicare, etc.

Such a shift was simulated with MCM and the results indicated that once a new steady state was attained, Hospital net income available for reinvestment in facilities and equipment was up by nearly $300,000 per year. In addition, the number of full-time faculty in the Hospital was able to grow by over three percent, and revenue supporting research increased by nearly seven percent.

Although there are obviously many other factors (social, ethical, educational, institutional mission, etc.) besides those incorporated in MCM which would have to be considered in deciding on such a policy as that discussed here, the model can rapidly provide information about important operational and financial ramifications, thereby reducing the number of dimensions which must be dealt with intuitively.

Reduction of Indirect Expense Recovery

The National Institutes of Health (NIH) has announced that it may stretch its reduced 1983 budget by paying only 90 percent of the negotiated indirect cost recovery rates to research grant recipients. This potential 10 percent reduction would deprive the CWRU Academic Medical Center of over $600,000 per year in general operating revenue. MCM was used to explore the impact of this income loss.

Although the initial revenue loss from NIH represents only about 0.3 percent of the total revenue supporting the Academic Medical Center,

analysis using MCM reveals that as the impact of this loss ripples through the system, there is a "multiplier" effect resulting from the utilization of these funds. The result, with only this one change in place, is that after ten years the total annual revenues shrink approximately $2,300,000 or 1.4 percent. The total number of faculty drops 2.0 percent and annual direct research revenues decline by 2.5 percent. Even patient days of care delivered by the hospital per year go down by 0.7 percent.

In summary, it would appear that it can be argued that NIH is getting an excellent return on its investment when it covers its share of indirect costs. When other revenue streams must be diverted to cover a larger share of indirect costs, the total scale of activity of the Center shrinks to a much larger extent that the proportion represented by the original reduction.

## DISCUSSION AND CONCLUSION

This project demonstrates that a useful and comprehensive model of an academic medical center can be structured and implemented which can incorporate a wide variety of factors, influences, and effects normally thought to be of a qualitative nature. Using the system dynamics approach and the Dynamo language, MCM takes into account factors such as the effect of quality of plant and equipment on the ability to recruit faculty, the impact of level of student aid on the ability to recruit students, the synergistic effects that appear in research productivity once an institution's programs exceed a certain minimum size, etc. The form and magnitude of the relationships involving such effects were generally estimated based on discussions with key people who have relevant experience in the institutions. The validity of such estimates is being assessed by

setting parameters in the model so that it will react to a specific effect, and then reviewing model outputs with knowledgeable people. This process often results in additional "fine-tuning" of the model which is expected to continue for as long as the model is used as a strategic planning tool.

The communication process described above is critical to the implementation of a realistic model and is also essential in assuring its credibility among the institutional leadership. Perhaps the most important benefit that accrues from the modeling process is the understanding that is derived of the system being modeled. As stated by Richardson and Pugh (1981), "A system dynamics model exposes its assumptions about a problem for criticism, experimentation, and r formulation" (p.3). The rigor and clarity which is demanded in formulating a simulation model forces critical thinking about how an organization functions. This process is not likely to occur to the same depth without the incentive of trying to constuct a realistic and useful model.

ACKNOWLEDGEMENTS

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## References

Ayers, W. R., Stangert, A. C., Dennis, M. J., & Henry J. B. Impact of high tuition on medical school applicants enrollees. Journal of Medical Education, October 1981, 56, No. 10, 795-802.

Forrester, J. W. Principles of systems (2nd. preliminary ed. - 9th printing). Cambridge, Massachusetts: MIT Press, 1980.

Forsyth, B. R., Laverty, R., & Hebert, P. Programmatic computer simulation model for medical school planning. Journal of Medical Education, August 1975, 50, No. 8, 757-764.

Hirsch, G. B., Forsyth, B. R., Bergan, T. A., & Goodman, M. R. Projecting a teaching hospital's future utilization: a dynamic simulation approach. Journal of Medical Education, November 1976, 51 No. 11, 937-938.

Judy, R. W. Systems analysis and university planning. Socio-Economic Planning Sciences, April 1969, 2, 179-199.

Kutina, K. L., & Lee, L. E., Jr. POPS - A program oriented planning system for academic health centers. Paper presented at the Operations Research Society of America/The Institute of Management Science Joint National Meeting, Boston, April 22-24, 1974.

Pugh, A. L., III. Dynamo user's manual. (5th edition). Cambridge, Massachusetts: MIT Press, 1976.

Richardson, G. P. & Pugh, A. L. III: Introduction to system dynamics modeling with DYNAMO. Cambridge, Massachusetts: MIT Press, 1981.

Roberts, E. B. (Ed.). Managerial applications of system dynamics. Cambridge, Massachusetts: MIT Press, 1978.

Stearns, N. S., Bergan, T. A., Roberts, E. B., & Cavazos, L. F. A systems intervention for improving medical-school-hospital interrelations. Journal of Medical Education, June 1978, 53, No. 6, 464-472.

Thompson, R. F. Higher education administration: an operating system study utilizing a dynamic simulation model. A. N. Schrieber (Ed.), Corporate simulation models. Seattle: University of Washington Printing Plant, 1970.

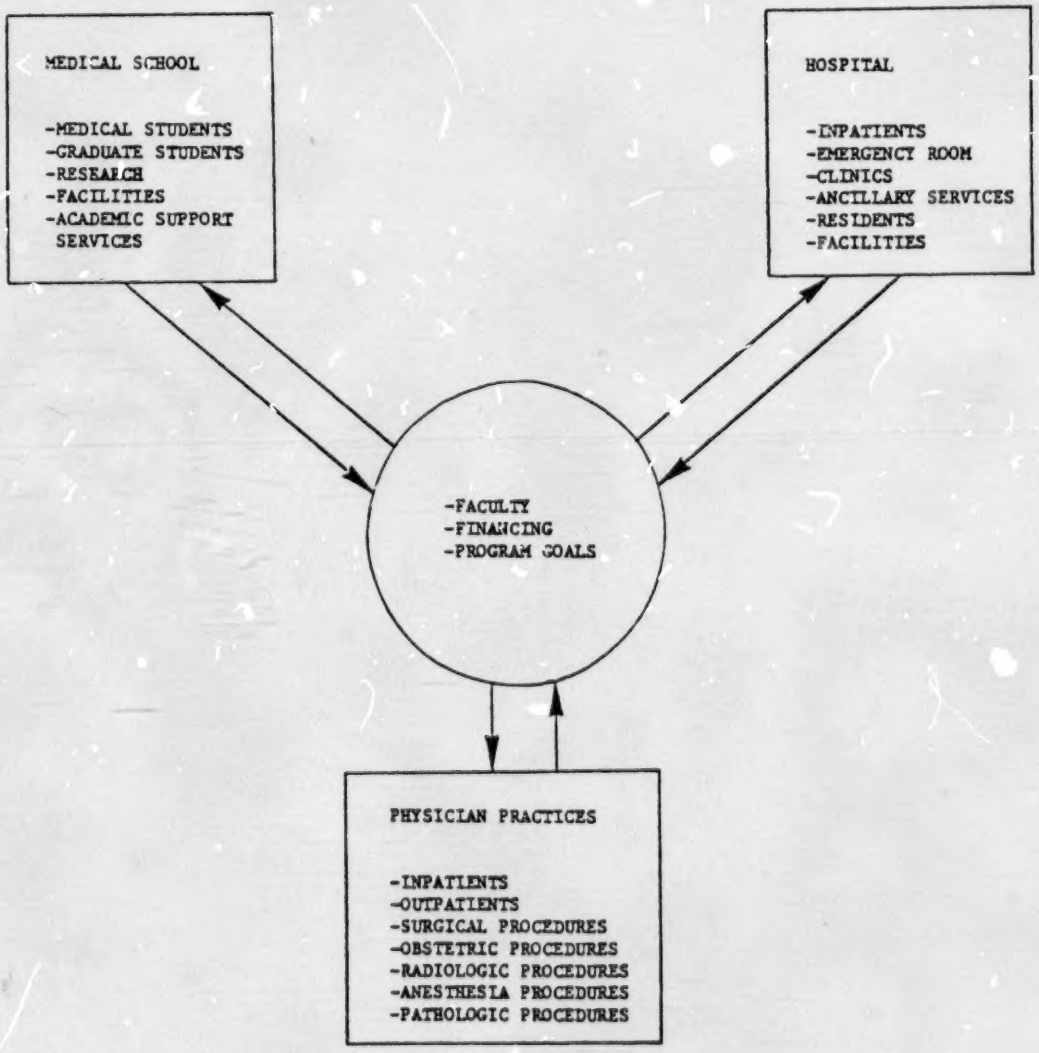


FIGURE 1. Academic Medical Center

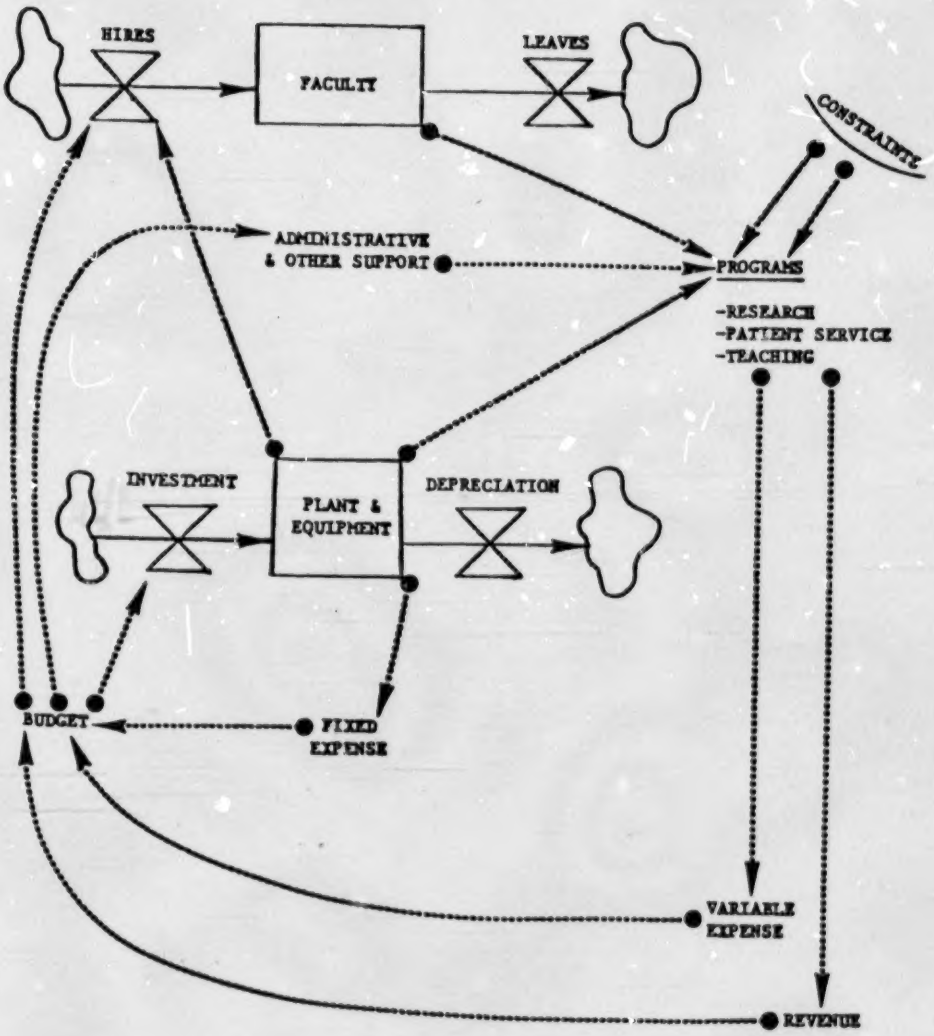


FIGURE 2. Model Overview

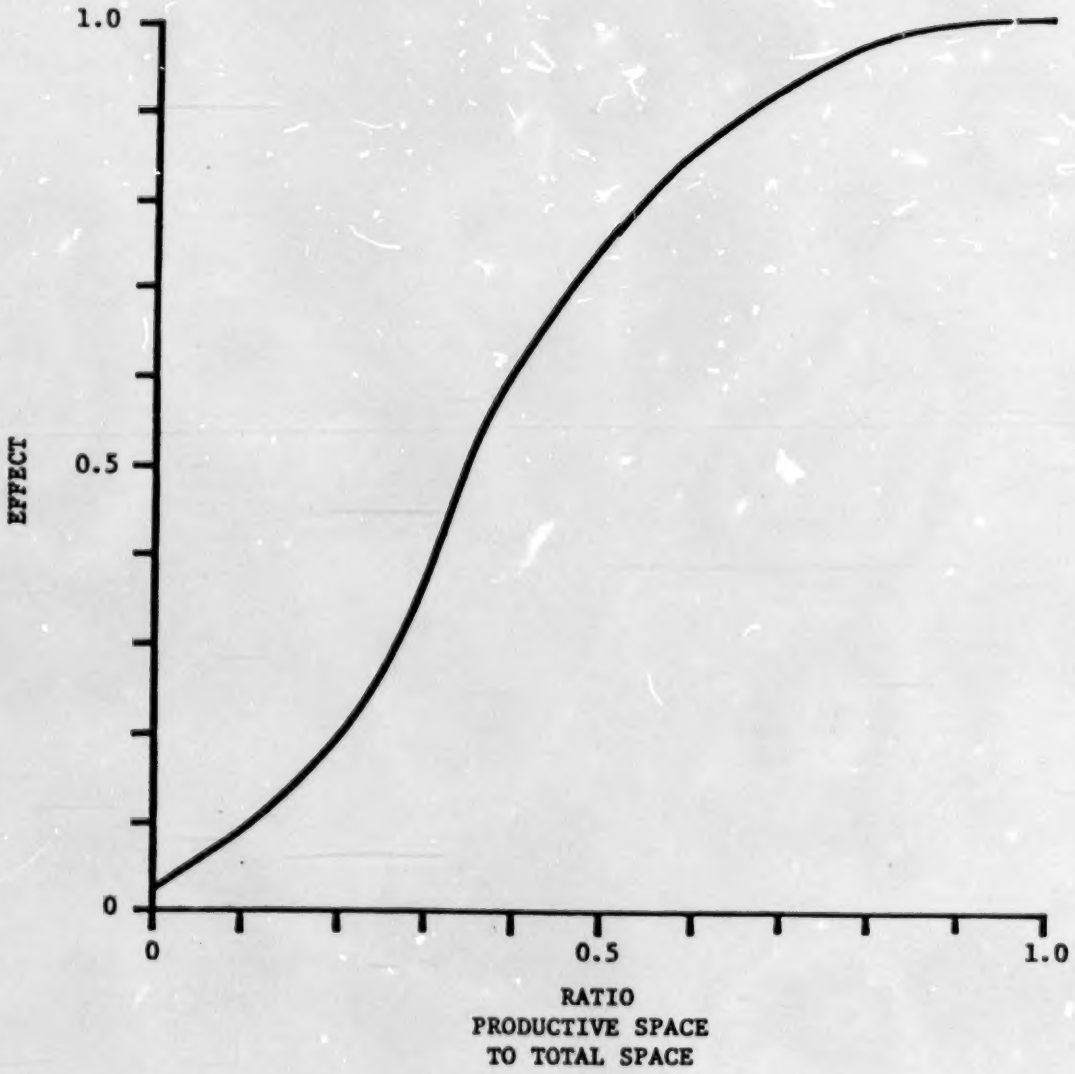


FIGURE 3. Effect of Clinical Space Condition on Faculty Hire Rate

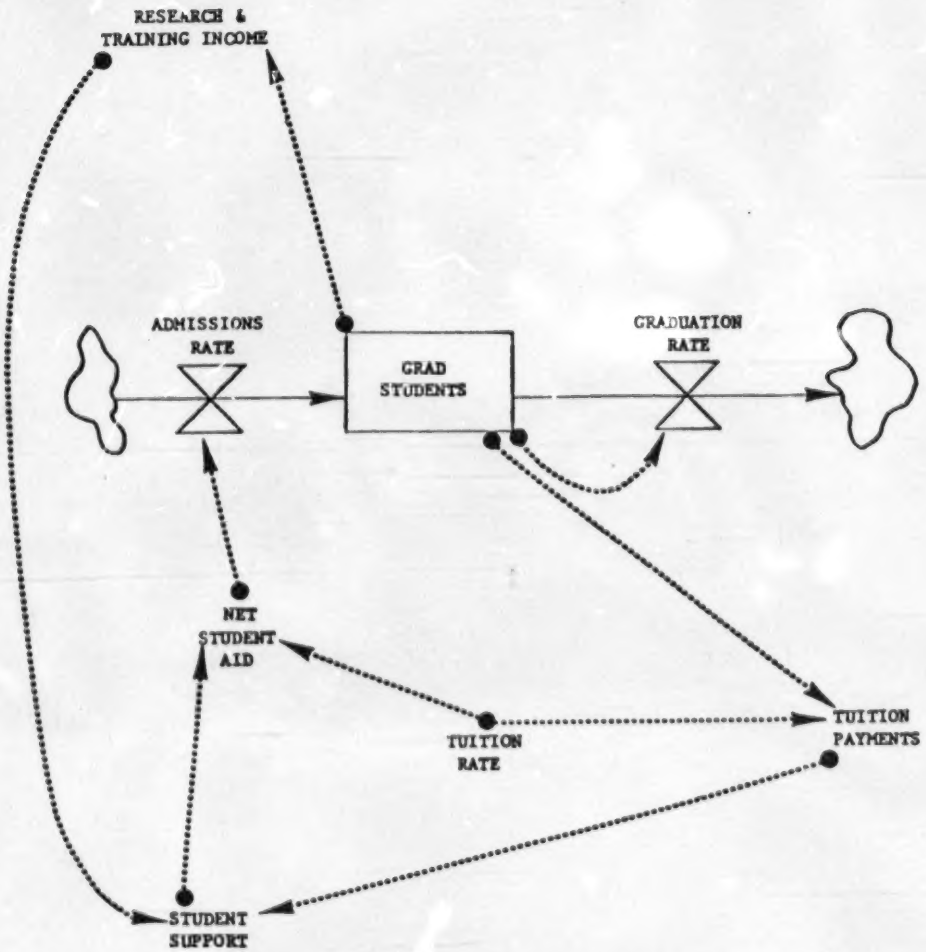


FIGURE 4. Graduate Student Subsystem

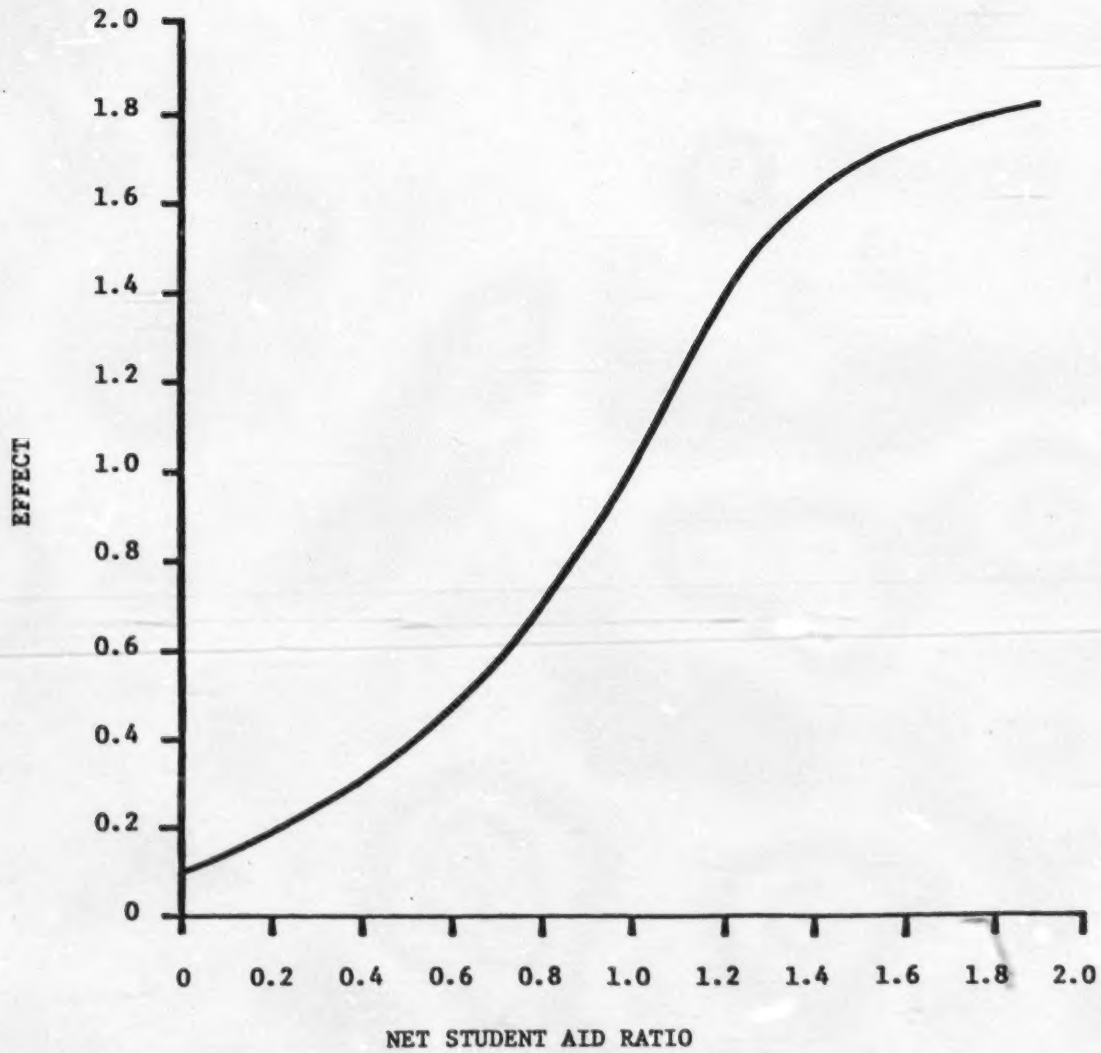


FIGURE 5. Impact of Student Aid on Graduate Student Recruitment

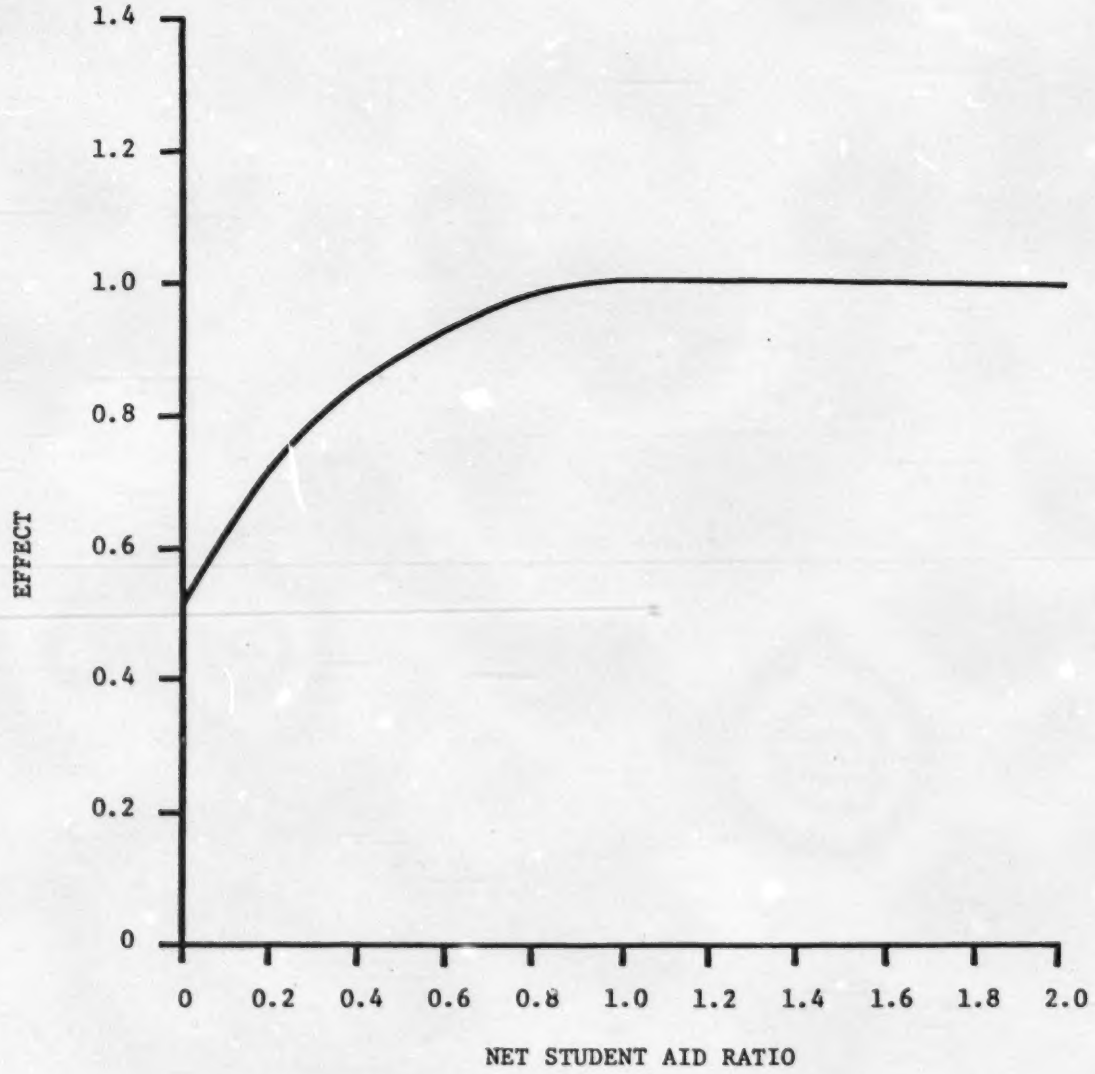


FIGURE 6. Impact of Student Aid on Medical Student Recruitment

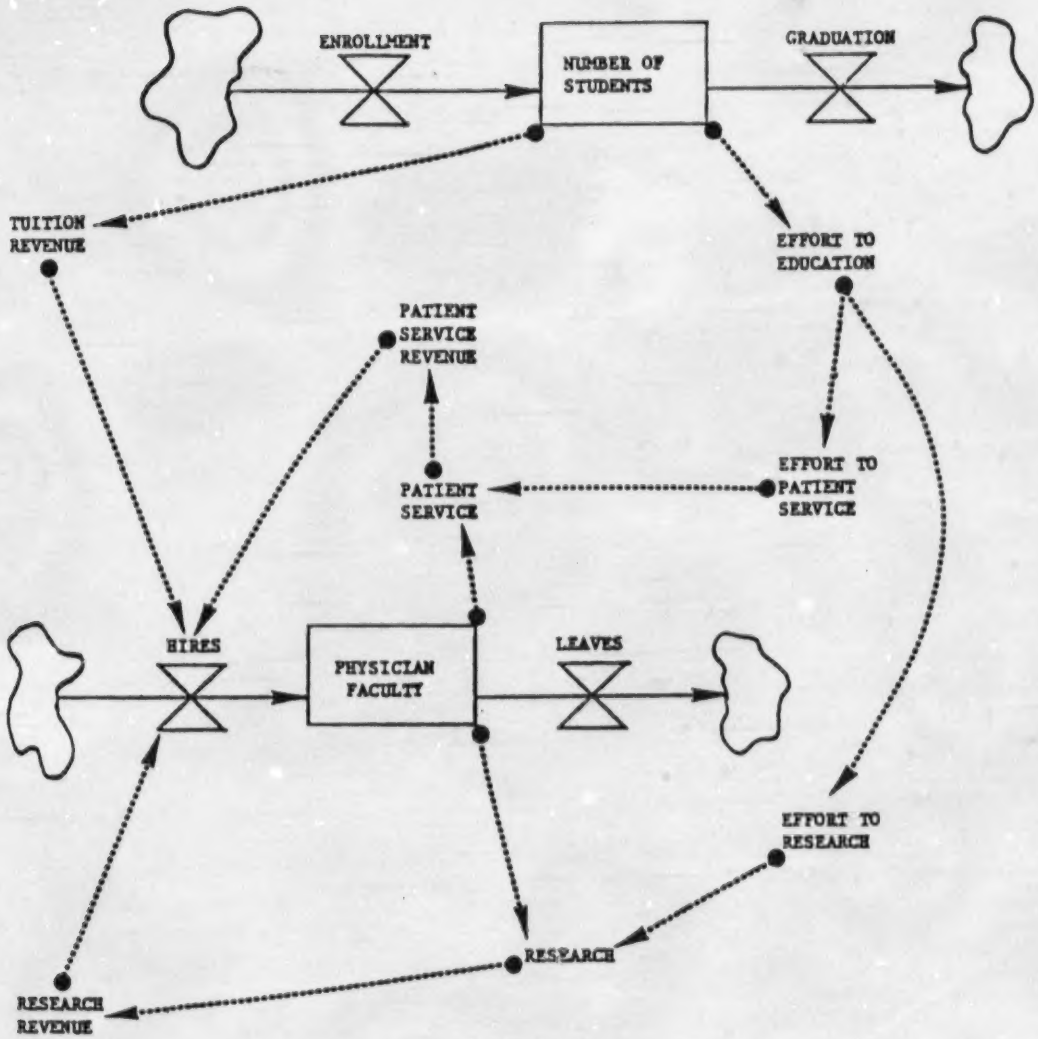


FIGURE 7. Allocation of Faculty Effort

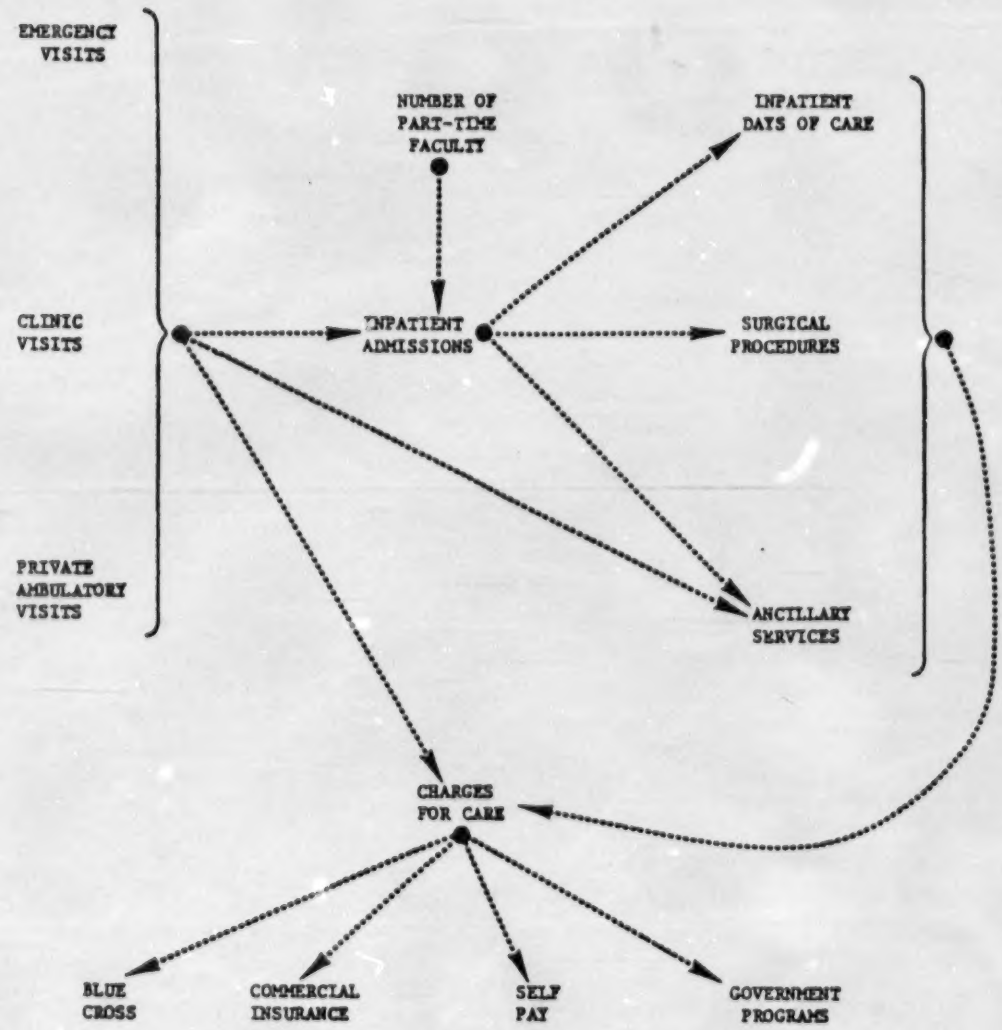


FIGURE 8. Patient Care Sector

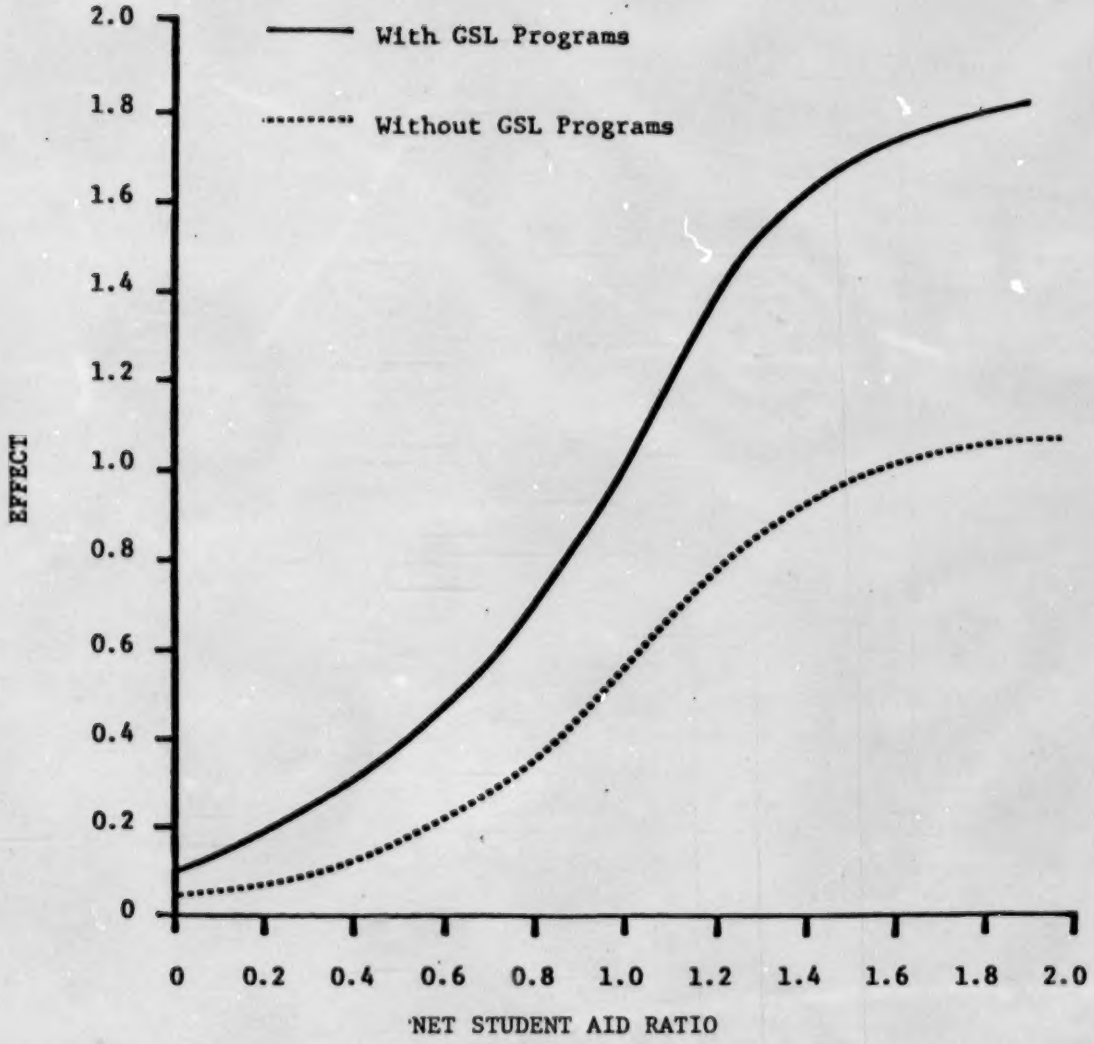


FIGURE 9. Impact of Student Aid on Graduate Student Recruitment